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"Eye in the Sky: A New Look at the Seyfert Connection"

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Annual Status Report for NAG5-2556

"Eye in the Sky: A New Look at the Seyfert Connection"

David J. Helfand

Observations obtained under this *ASCA* grant have been fully reduced. We have also extracted data from the *ROSAT* archive to complement the *ASCA* spectrum, and demonstrate that the source is time variable, a key clue to its nature. A paper describing these results is nearly ready for submission. Below we describe briefly the key findings of the project. We reserve only sufficient funds in the grant to pay for the page charges when the paper is published.

In the *ROSAT* All-Sky Survey, the reported luminosity of *IRAS* 00317-2142 is $\sim 10^{43}$ ergs s^{-1}, which is typical for a broad-line Seyfert galaxy. However, at all other wavelengths, the characteristics of this object are dominated by the signatures of a nuclear star-forming region, which are normally 2–3 orders of magnitude fainter than this in the X-ray band. At 1.4 GHz, the emission from the galaxy is amorphous, extending over several kiloparsecs. In fact, 94% of the 20 cm flux is associated with extended, steep-spectrum emission from the starburst. Only at 8.4 GHz is the faint, unresolved AGN core unambiguously revealed. The optical emission-line flux ratios are also suggestive of vigorous star formation in IRAS 00317-2142. Broad [O III] lines and weak, broad wings on the Hα line provide subtle indications of the presence of a Seyfert nucleus. Similarly, the UV spectrum of the galaxy possesses absorption features associated with very young, hot stars, as well as a strong Lyman alpha emission line, suggesting once more composite starburst/Seyfert activity.

To reconcile the high soft X-ray luminosity of *IRAS* 00317-2142 with its properties at other wavelengths, we observed the galaxy with the *ASCA* satellite on 12/12/95 for 37 ks with the SIS and 41 ks with the GIS; a fit to the combined spectra is shown in Figure 1. In combination with an archived 9.3 ks *ROSAT* PSPC observation, obtained

6/23/92 (Figure 2) these data reveal significant spectral and flux variability, which indicates unambiguously that the AGN dominates in the X-ray band. Both the PSPC and *ASCA* spectra are adequately fitted with simple absorbed power-law models. The measured power-law photon index in the PSPC spectrum is 2.46 ± 0.20 (90% conf.), from which we derive a 0.5–2.4 keV flux of 1.8^{-12} ergs cm^{-2}s^{-1}. In the *ASCA* spectrum, $\gamma = 1.88 \pm 0.08$, with a 0.5–2 keV flux of 5.0^{-13} ergs cm^{-2}s^{-1}. The soft X-ray flux dropped by a factor of 3.6 over a three-and-a-half year span. The PSPC light curve (Figure 3) indicates $\sim 30\%$ variability on the timescale of a day.

So why is the AGN in IRAS 00317-2142 so inconspicuous at other wavelengths, particularly in the optical? The absorption columns needed in the power-law fits are low (2.6×10^{20} cm^{-2}, just above the Galactic column density), so the AGN is not heavily obscured. In fact, the ratio of the 2–10 keV to broad H alpha flux, which has a mean value of 40 (with large dispersion) for luminous AGNs, is 9 in *IRAS* 00317-242, indicating that the AGN is *not* anomalously weak in the optical. We have every indication that *IRAS* 00317-2142 and the other starburst/Seyfert composite galaxies we discovered in other programs are merely objects that exhibit normal amounts of both types of activity, which is not common in late-type galaxies. Thus, they do not form a new class of luminous X-ray sources: they are instead cleverly disguised examples of objects with which we are already well acquainted.

Although somewhat prosaic, these results are very significant in the context of the so-called "narrow-line X-ray galaxies" which are being discovered with increasing frequency in surveys of faint *ROSAT* sources. It may well be that these too are unremarkable and are included in current counts of Seyfert galaxies, meaning they are *not* the long-sought new component of the cosmic X-ray background.

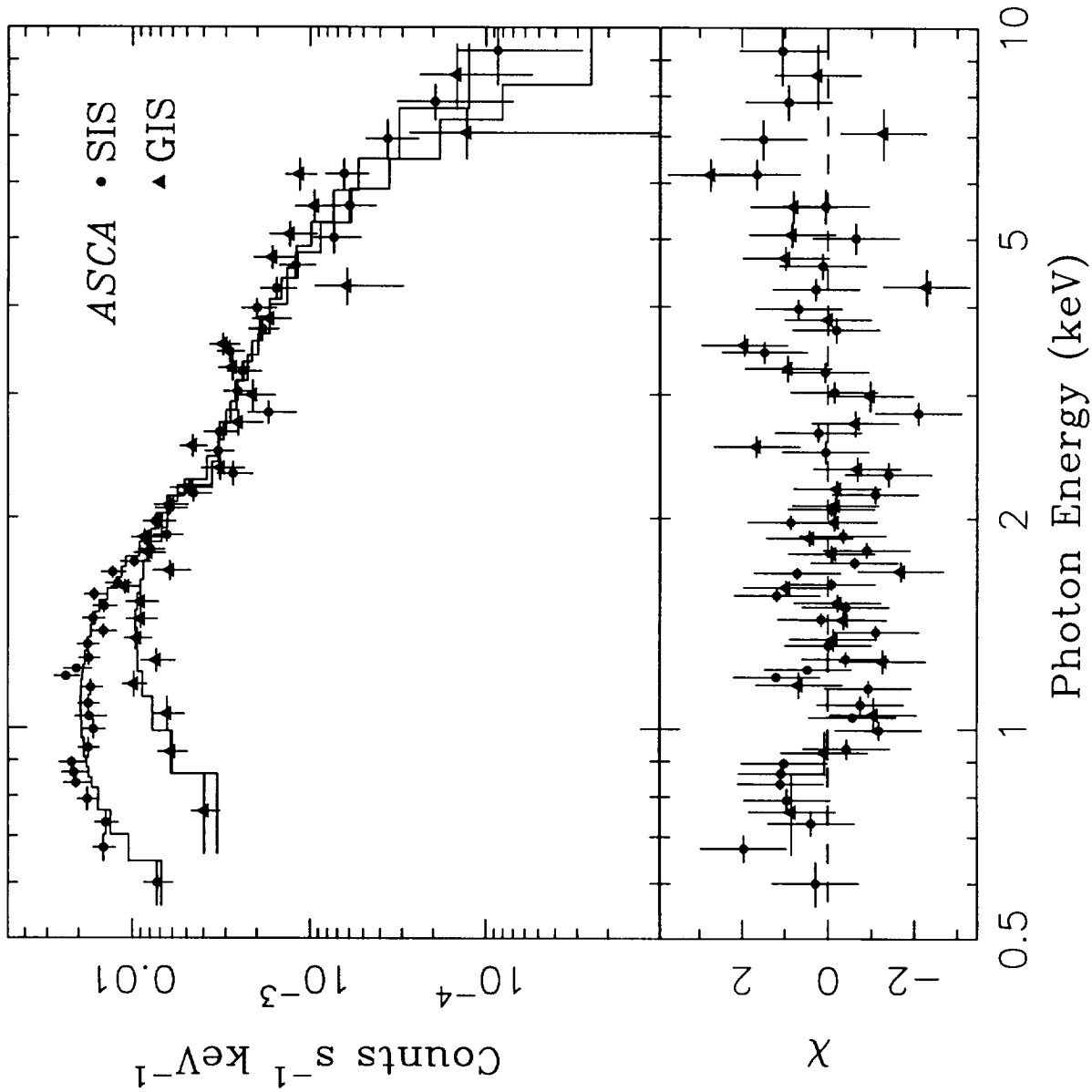

ASCA • SIS ▲ GIS
Counts s^{-1} keV^{-1}
10^{-4}
10^{-3}
0.01
χ
−2
0
2
0.5
1
2
5
10
Photon Energy (keV)

Fig. 1

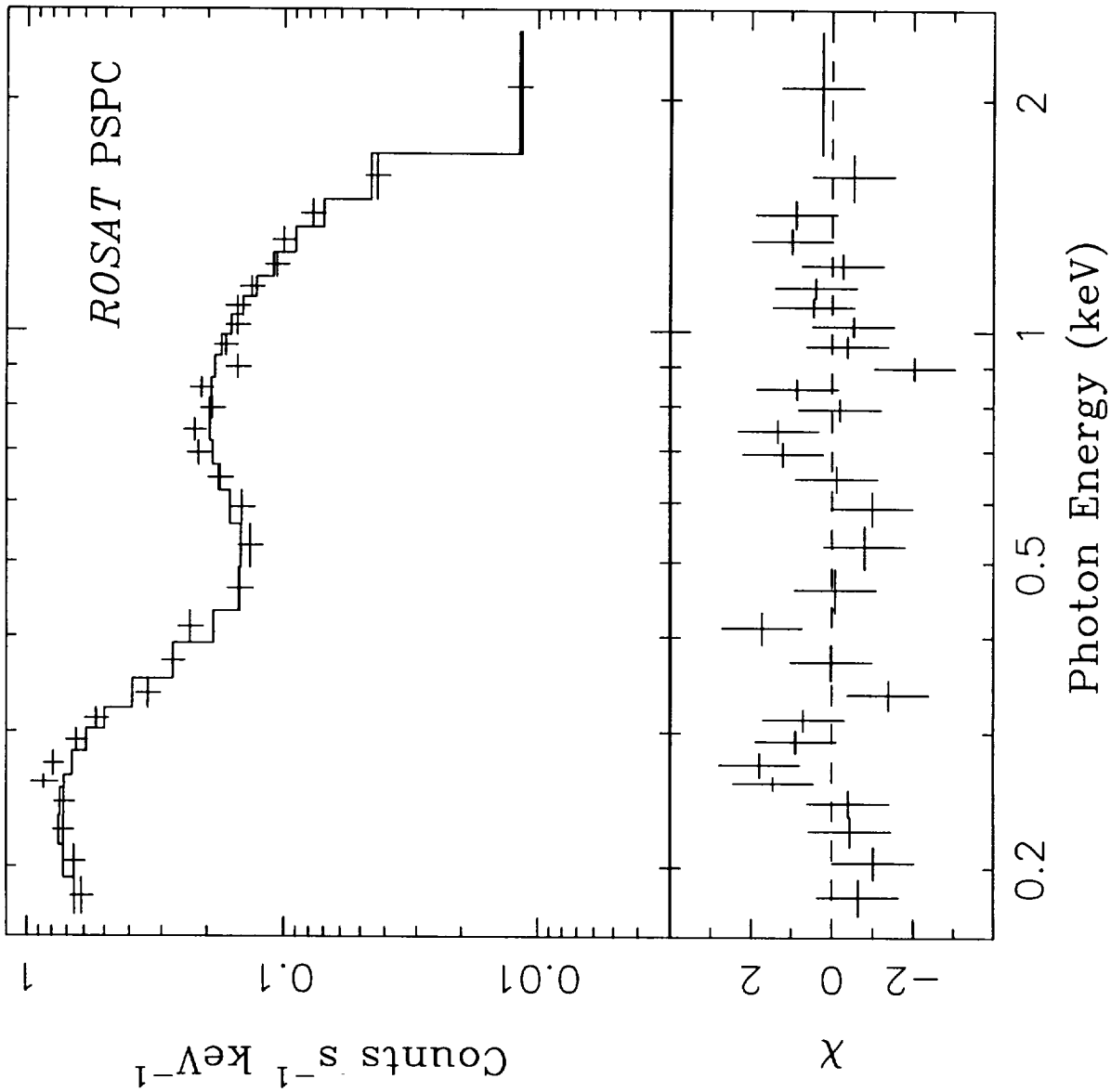
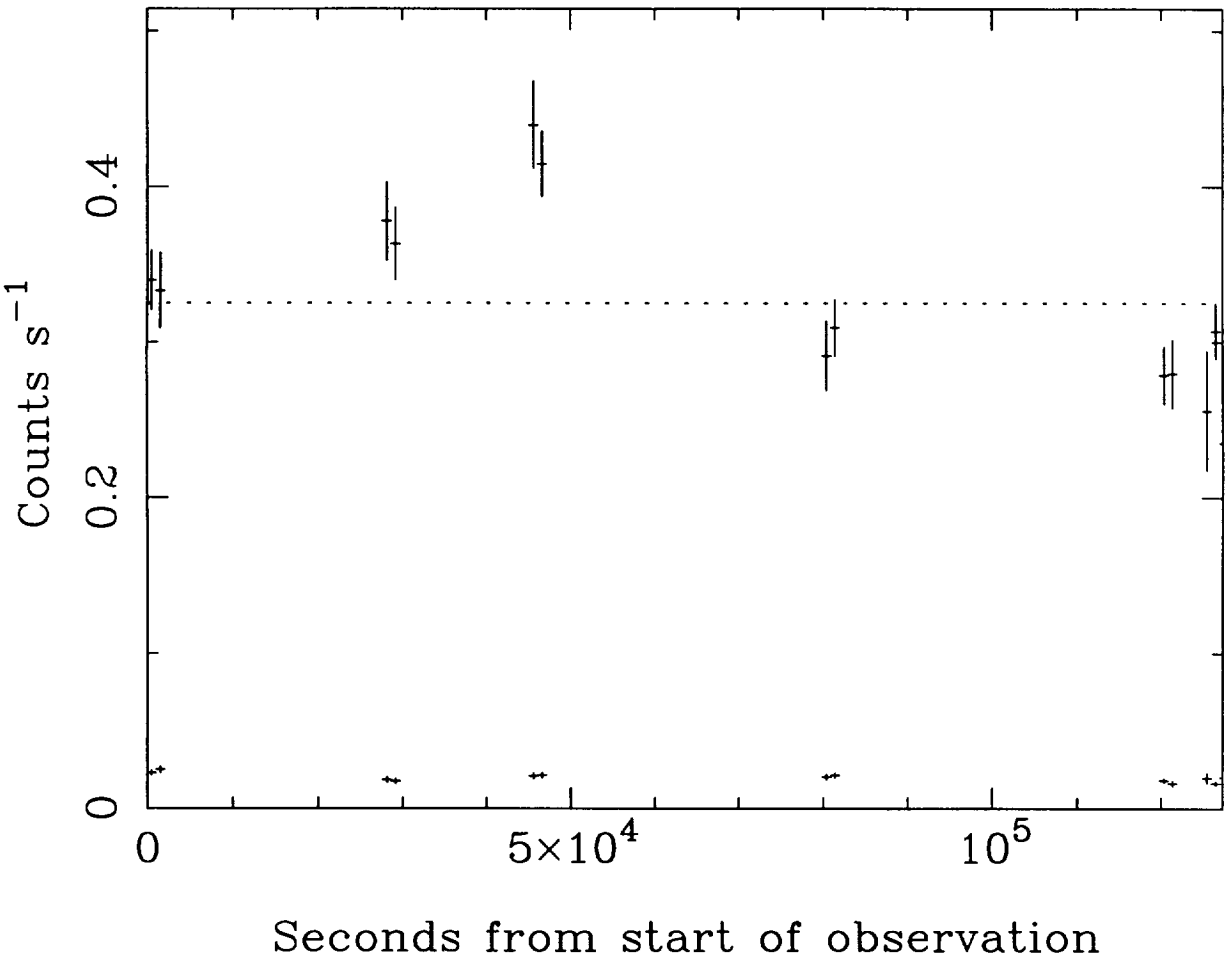

ROSAT PSPC
Counts s^{-1} keV^{-1}
1
0.1
0.01
χ
2
0
−2
0.2
0.5
1
2
Photon Energy (keV)

Fig. 2


Counts s^{-1}
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0.2
0.4
0
5×10^4
10^5
Seconds from start of observation

Fig. 3